of the contest which, as a living being, it has to maintain against the surrounding influences which are ever tending to dissolve the vital bond and subjugate the organised matter to the ordinary chemical and physical forces. Any changes, therefore, in the external circumstances in which a species may have been created to exist, will militate against that existence in probably a geometrical ratio to the bulk of such species. If a dry season be gradually prolonged, the large mammal will suffer from the drought sooner than the small one; if such alteration of climate affect the quantity of vegetable food, the bulky Herbivore will first feel the effects of the stinted nourishment; if new enemies are introduced, the large and conspicuous quadruped or bird will fall a prey, whilst the smaller species might conceal themselves and escape. Smaller quadrupeds are usually, also, more prolific than larger ones. The actual presence therefore of small species of animals in countries where the larger species of the same natural families formerly existed, is not to be ascribed to any gradual diminution of the size of such larger animals, but is the result of circumstances which may be illustrated by the fable of 'the oak and the reed'; the small animals have bent and accommodated themselves to changes under which the larger species have succumbed.

May 15, 1851.

The EARL OF ROSSE, President, in the Chair.

The following papers were read:—

1. "Note relating to M. Foucault's new mechanical proof of the Rotation of the Earth." By C. Wheatstone, Esq., F.R.S., Corresponding Member of the Academies of Science of Paris, Berlin, Brussels, Turin, Rome, Dublin, &c. Received May 15, 1851.

The experiment which led M. Foucault to his ingenious and interesting researches relating to the rotation of the earth, is stated by him thus:—"Having fixed on the arbor of a lathe and in the direction of the axis, a round and flexible steel rod, it was put in vibration by deflecting it from its position of equilibrium and leaving it to itself. A plane of oscillation is thus determined, which, from the persistence of the visual impressions, is clearly delineated in space; now it was remarked that, on turning by the hand the arbor which serves as a support to this vibrating rod, the plane of oscillation is not carried with it."

This persistence of the plane of oscillation of a vibrating rod, notwithstanding the rotation of the point to which its end is fixed, does not appear to have hitherto been made the subject of philosophical observation. Ordinary notions even seem to have been opposed to this now recognised fact. Chladni in his treatise on Acoustics, in the chapter "On the co-existence of vibrations with other kinds of motion," states as follows:—

"Vibratory motions may co-exist with all other kinds of motions

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in an infinity of different manners, as has been demonstrated by Dan. Bernoulli and L. Euler in vols. xv. and xix. of the *Nov. Comment. Acad. Petrop.*, and confirmed by experiment. These coexistences of different motions occur in all sonorous bodies without exception: we may, for example, produce the sound of a string stretched on a board, or that of a plate, a tuning-fork, a bell, &c.; and while the vibrations still last, impress on this sonorous body a motion of rotation round its axis, and at the same time a progressive motion: thus all these motions may be performed in the same time, without one being hindered by the other; but the absolute motion of each point will be very complicated."

Now this is true only when the vibrating body is constrained to vibrate in one direction. When the rod or string is equally flexible in every direction, the plane of vibration given to it from any original impulse is constantly maintained whatever may be the velocity of rotation communicated to its point of support, provided the axis of vibration remains in the same position, or moves only parallel to itself.

This observed independence of the plane of oscillation on the point of attachment led M. Foucault to assume, that were a flexible pendulum suspended from a fixed point in the prolongation of the axis of the earth, that is above one of the poles, and maintained constantly in vibration, the plane of oscillation maintaining an invariable position in space would appear to a spectator on the earth's surface and moving with it to make an entire revolution in twenty-four hours, but in the opposite direction to that of the rotation of the earth.

What takes place at other points of the earth's surface is more difficult to determine; but M. Foucault, from mechanical and geometrical considerations, was led to the conclusion that the angular displacement of the plane of oscillation is equal but opposite to the angular motion of the earth multiplied by the sine of the latitude. According to the theory of rotation, first established by Frisi and more fully developed by Euler and Poinsot, the velocity of rotation of the earth may be considered as the resultant of two angular velocities, one round the vertical of the point where the observer is placed, and the other round the meridian or horizontal line lying N. and S. The component of the angular velocity estimated round the vertical axis is $n \sin \gamma$, and the plane of oscillation not participating in this motion remains at rest with respect to it, and therefore appears to an observer moving with the point, to rotate with the same velocity in the contrary direction.

The experiment made by M. Foucault is said, both in the direction and magnitude of the motion of the plane of oscillation of the pendulum, fully to confirm the indications of theory. The difficulty, however, of the mathematical investigation of the subject, and the delicacy of the experiment, liable as it is to so many extraneous causes of error, have induced many persons to doubt either the reality of the phænomenon or the satisfactoriness of the explanation. Another experimental proof, therefore, not depending on the rotation of the earth, that the plane of oscillation of a vibrating line remains at rest with relation to the vertical component of the real axis of rotation, may not be unacceptable. With this view I have devised the apparatus I am about to describe.

A semicircular arch from one to two feet radius is fixed vertically on a horizontal wheel, and may thus be moved with any degree of rapidity from any one azimuth to another. A rider slides along the inner edge of the arch, which is graduated, and may be fixed at any degree marked thereon. A spiral spring wire, by means of which a slow vibration is obtained with a comparatively short length, is attached at the lower end to a pin fixed in the axis of the semicircle, so that the point of attachment may be in the axis of rotation, and at the upper end it is fixed to a similar pin in a parallel position fixed to the rider. The vertical semicircle is not placed in a diameter of the horizontal wheel, but parallel to it, at such distance as not to intercept, from the eye of the observer, the vertical plane passing through the diameter, and in which plane the wire in all its positions remains.

When the upper end of the wire is placed at 90°, that is when it coincides with the axis of rotation, if the wire be caused to vibrate in any given plane, say from N. to S., it will continue to do so whatever rotation may be communicated to the wheel; so that with respect to the moving wheel, or the axis of the wire, the plane of vibration will move with the same velocity and in the opposite direction. When the rider is fixed at 30°, and the wire makes therefore an angle of 60° with the axis of rotation so as to describe in its motion the surface of a cone having this inclination to the vertical, it will be observed that the plane of vibration makes one complete rotation during two rotations of the wheel: this is best observed by fixing the eye so that its axis shall coincide with a line in the same vertical plane with the wire, while walking round with the wheel during its rotation. When the rider is fixed at 19½°, the plane of vibration makes one rotation during three rotations of the wheel; when fixed at 14½°, it makes one rotation during four of the wheel, &c.; and when it is fixed at 0°, the wire lying horizontally, no rotation of the plane of vibration occurs. It is needless to observe that the sines of 90°, 30°, 19½°, 14½°, 0°, correspond to the numbers 1, ½, ⅓, ¼, 0, the reciprocals of the numbers expressing the respective times of rotation*.

It is not necessary that the wire should have one of its ends fixed in the axis of rotation: if it be parallel to a wire so fixed, the rotation of the plane of vibration will be exactly similar; in such case the wire or axis of vibration will describe the surface of two cones having their common apex in the axis of rotation.

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* When the dimensions of the apparatus are as above given, I find that hardened brass wire (No. 26), coiled so as to form a helix of one-quarter of an inch in diameter, shows the effect well. The thickest spiral wire employed in the manufacture of artificial flowers, which can be procured of any wire-drawer, will also answer the purpose.

The best way of setting the wire in vibration is to press the finger upon it in the middle, so as to deflect it in the plane in which the vibrations are required to continue, and then suddenly to withdraw the finger in the direction of the vibrations. The deflection must not be too great, or the elasticity of the wire will be injured.

The axis of a flexible pendulum can only assume a position vertical to the point of the earth's surface over which it is placed. Were it possible to maintain the vibration of a stretched wire occasioned by an original impulse, for a sufficient length of time, the apparent rotation of its plane of vibration would vary with the inclination of the wire to the axis of the earth: placed in this axis, it would make a rotation in 24 hours, it would become progressively slower according to the law above given, as it approaches the plane of the equator, and when anywhere in this plane the vibrations would always be performed in the same direction.

2. "Report of further Observations made upon the Tidal Streams of the English Channel and German Ocean, under the authority of the Admiralty, in 1849 and 1850." By Captain F. W. Beechey, R.N. Communicated by G. B. Airy, Esq., F.R.S. &c., Astronomer Royal. Received March 27, 1851.

This is the continuation of a report which the author made upon the tidal phenomena of the Irish Sea and English Channel in 1848. After detailing the manner in which the investigation had been conducted, and the great care which had been bestowed upon the observations, which are numerous, the author enters into an explanation of the whole system of tidal streams in the English Channel and North Sea, as deduced from these observations, and also as to what he considers to be the cause of the peculiar movement of the streams in these channels. He supposes, in conformity with Dr. Whewell's theory, a tide-wave to pass along the western shores of Europe, and to enter the English Channel and North Sea by opposite routes, and to arrive off the Texel and Lynn at the same tidal hour as the tide-wave in the English Channel arrives off the Start and Jersey. From these points there are thrown off branch or derivative waves, which differ materially both in dimensions and rate of travelling from the parent wave. These waves roll on towards the strait of Dover and there merge into each other and form a combined wave.

The effect of this wave upon the tidal establishments of the Channel had long been known; but its influence upon the streams of the Channel had never before been considered, nor had any observations upon them been systematically undertaken.

In arranging the plan of observation the author considered that, as the combined wave was common to both the English Channel and North Sea, the tidal streams of both these channels would be found to correspond in every important particular, and that the movement of the streams throughout the strait would be materially influenced, if not wholly governed, by the motion of the combined wave; that the time of this wave attaining its greatest altitude would thus afford a standard to which the turn of the streams throughout the Channel might be advantageously referred; and that there would be found in this Channel, as in the Irish Sea, which is equally under the influence of a combined wave, a stream which would turn nearly